

Using Aura information in NASA-Unified WRF applications on air quality, water and carbon cycles

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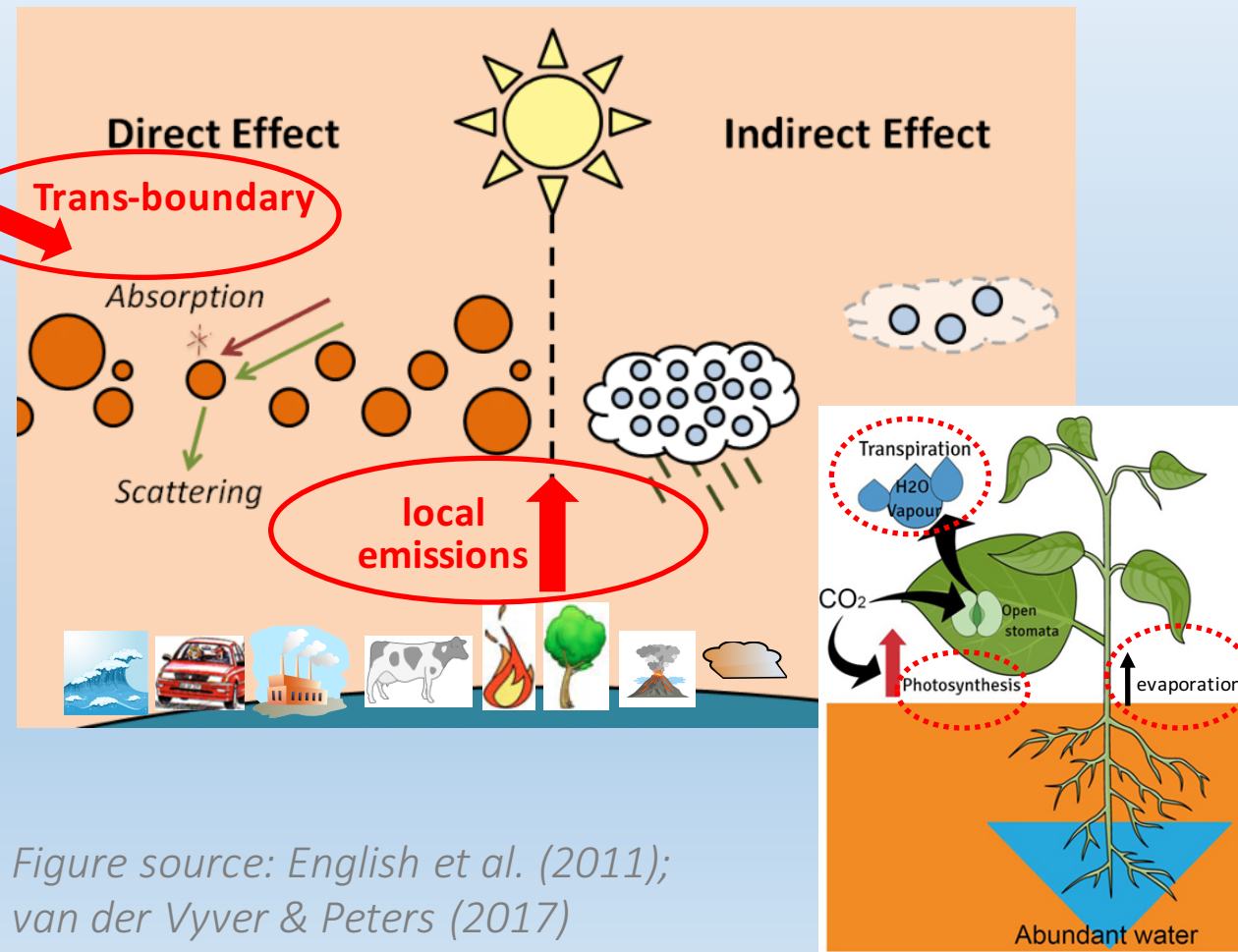
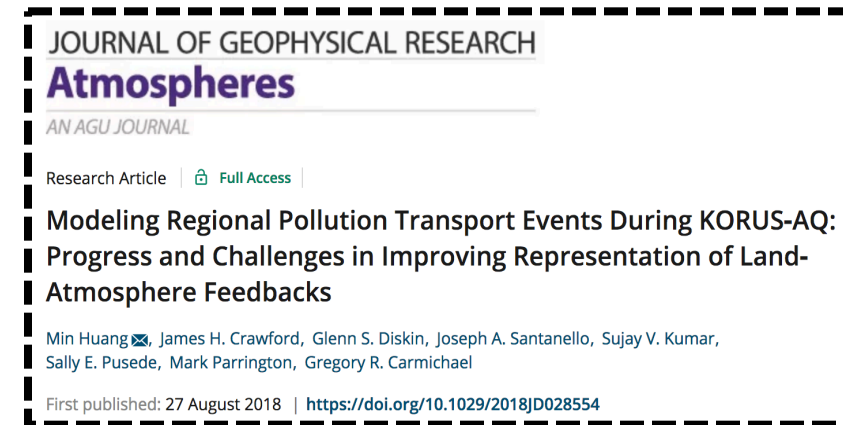
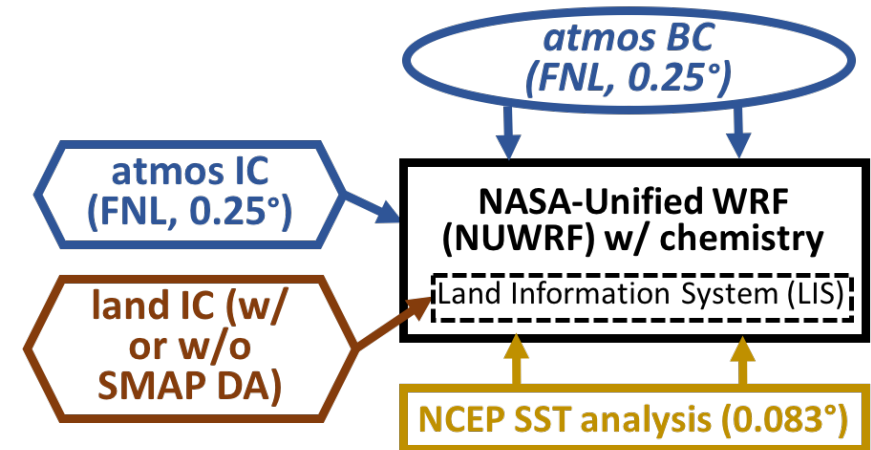
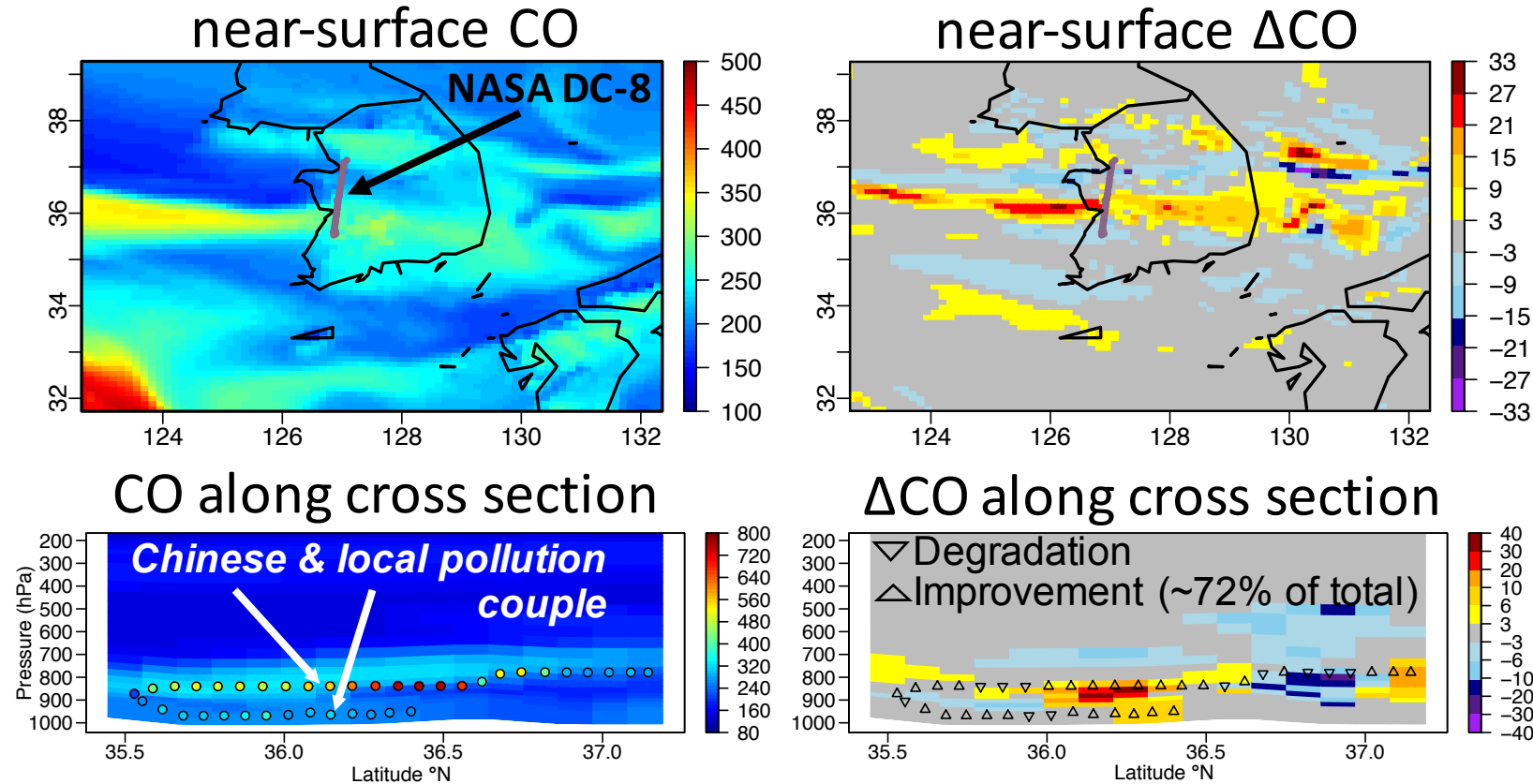


Figure source: English et al. (2011);
van der Vyver & Peters (2017)

Aura STM | Pasadena, CA | 28 Aug 2019

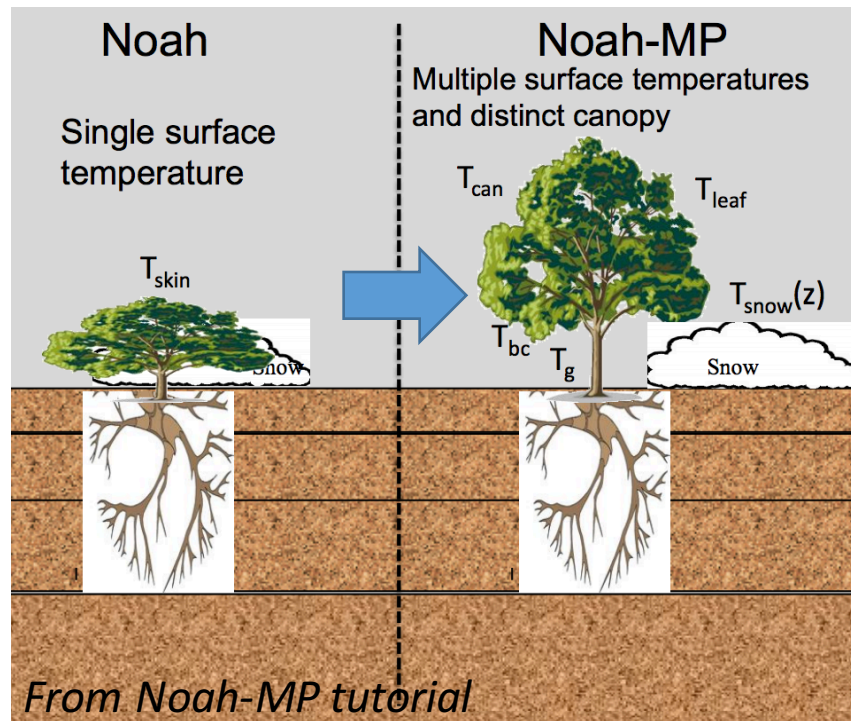
Hydrological modeling and data assimilation (DA) coupled with atmospheric modeling in NUWRF

SMAP soil moisture DA (into Noah LSM) impacts on NUWRF CO (ppbv) during a pollution transport event (31 May 2016)



- CO (& H₂O) improved in places, stronger for airmasses originating from outside of S Korea
- Chemical BC/IC: high-res ECMWF CAMS w/ multi-species chemical DA advantageous
- *Still need to jointly improve various emission inputs and land modeling/DA methods*

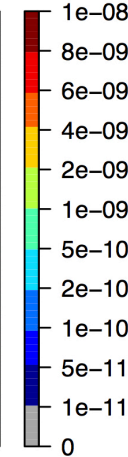
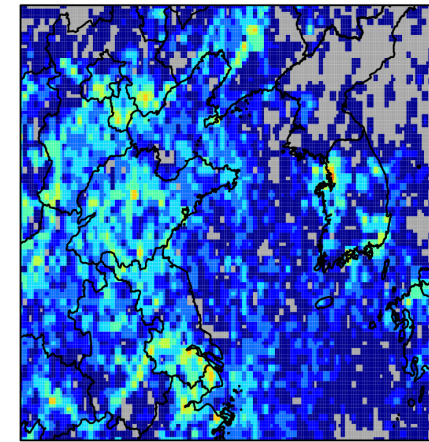
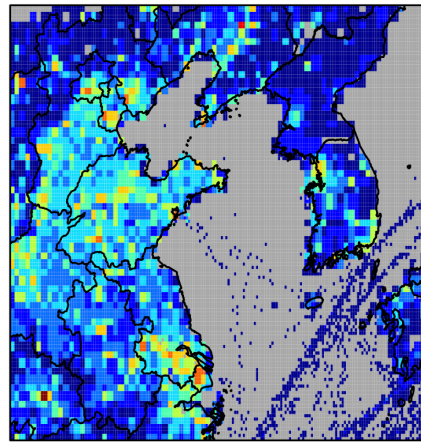
Emission impacts on atmosphere-biosphere interactions



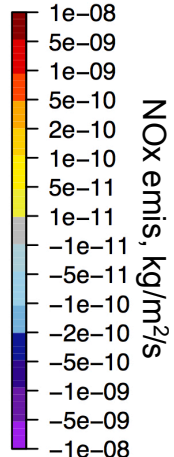
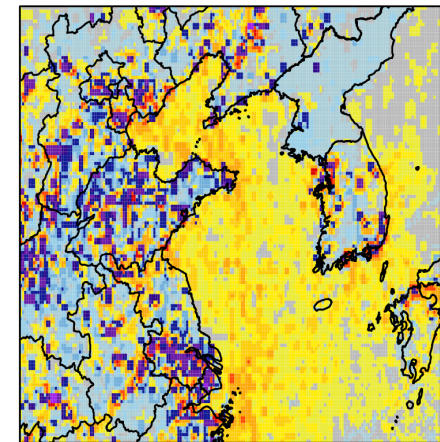
Noah-MP LSM:

- Separate vegetation canopy
- Dynamic vegetation w/ Ball-Berry stomatal resistance
- Multi-layer snowpack + other improvements from Noah

HTAP2, May 2010 DECSO-OMI, May 2016



DECSO-HTAP2



NUWRF experiments:

Base: largely based on HTAP2

Sensitivity: NOx emissions replaced with DECSO in urban & non-terrestrial areas (based on CCI land cover): **total anthropogenic emissions ~10% lower than base case, w/ urban & shipping >60 % of the total**

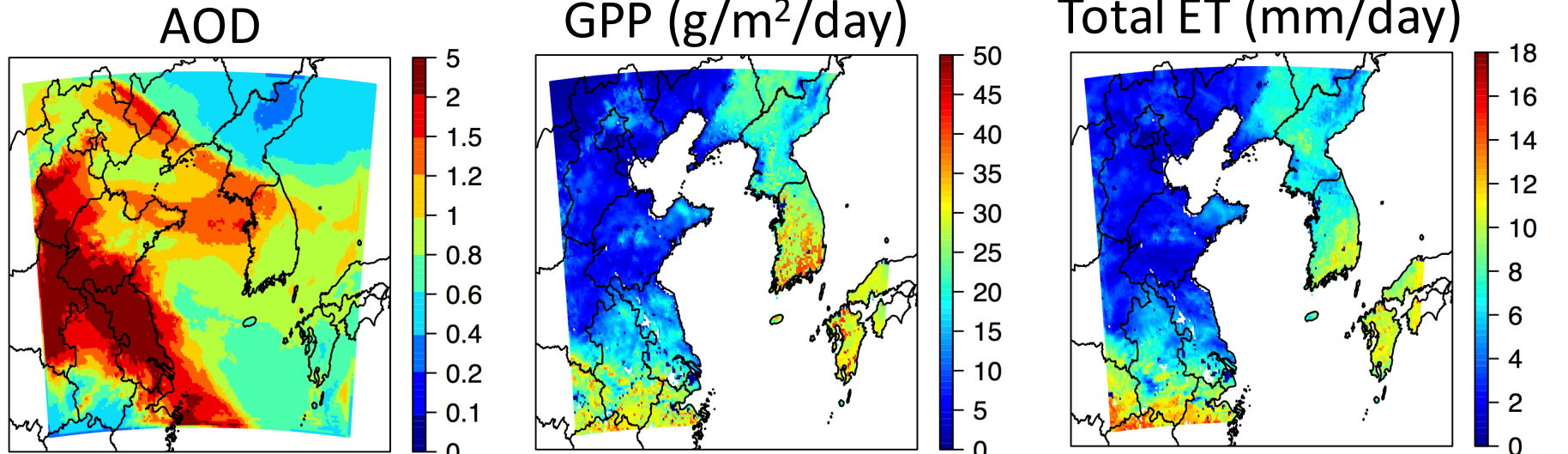
Both cases:

- Aerosol direct & indirect effects on
- NUWRF chemical fields compared with AERONET, GOCL, aircraft, ship obs
- GPP/ET compared with SMAP L4 carbon/COMS ET

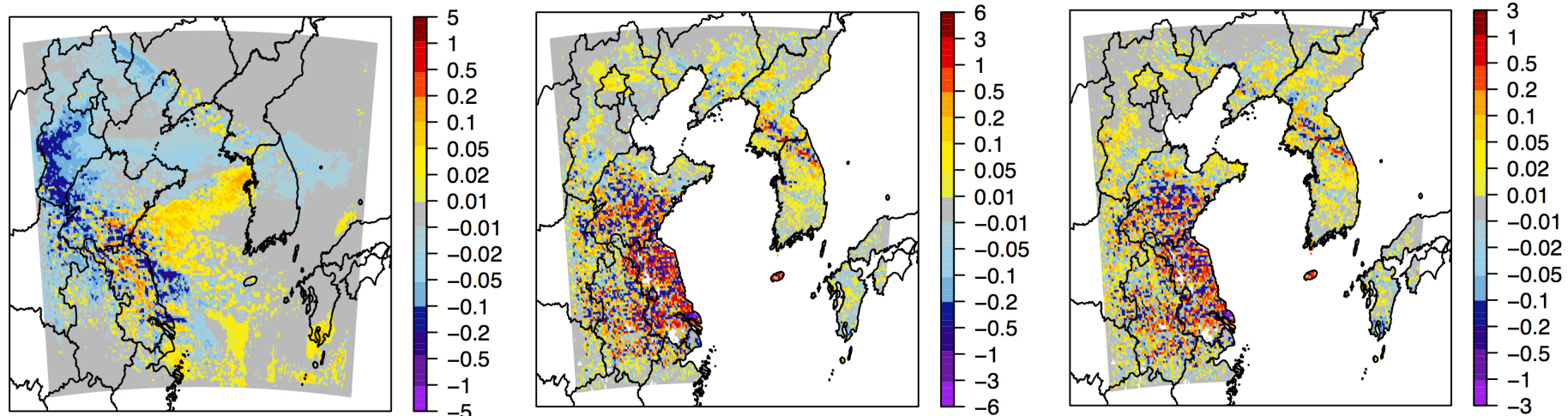
NUWRF sensitivities: 9-16 KST, 31 May 2016 (cloudy)

Huang et al. (2019):
in re-review

Base case



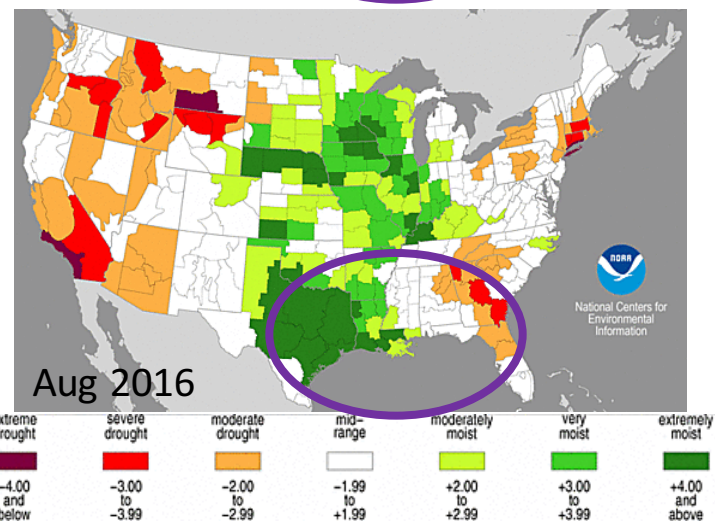
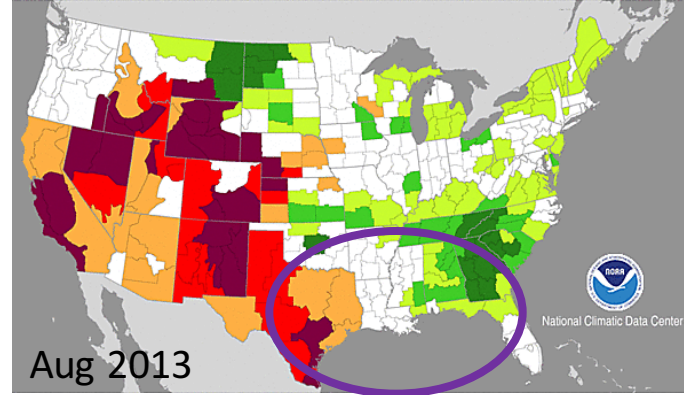
Sensitivity run
- base case



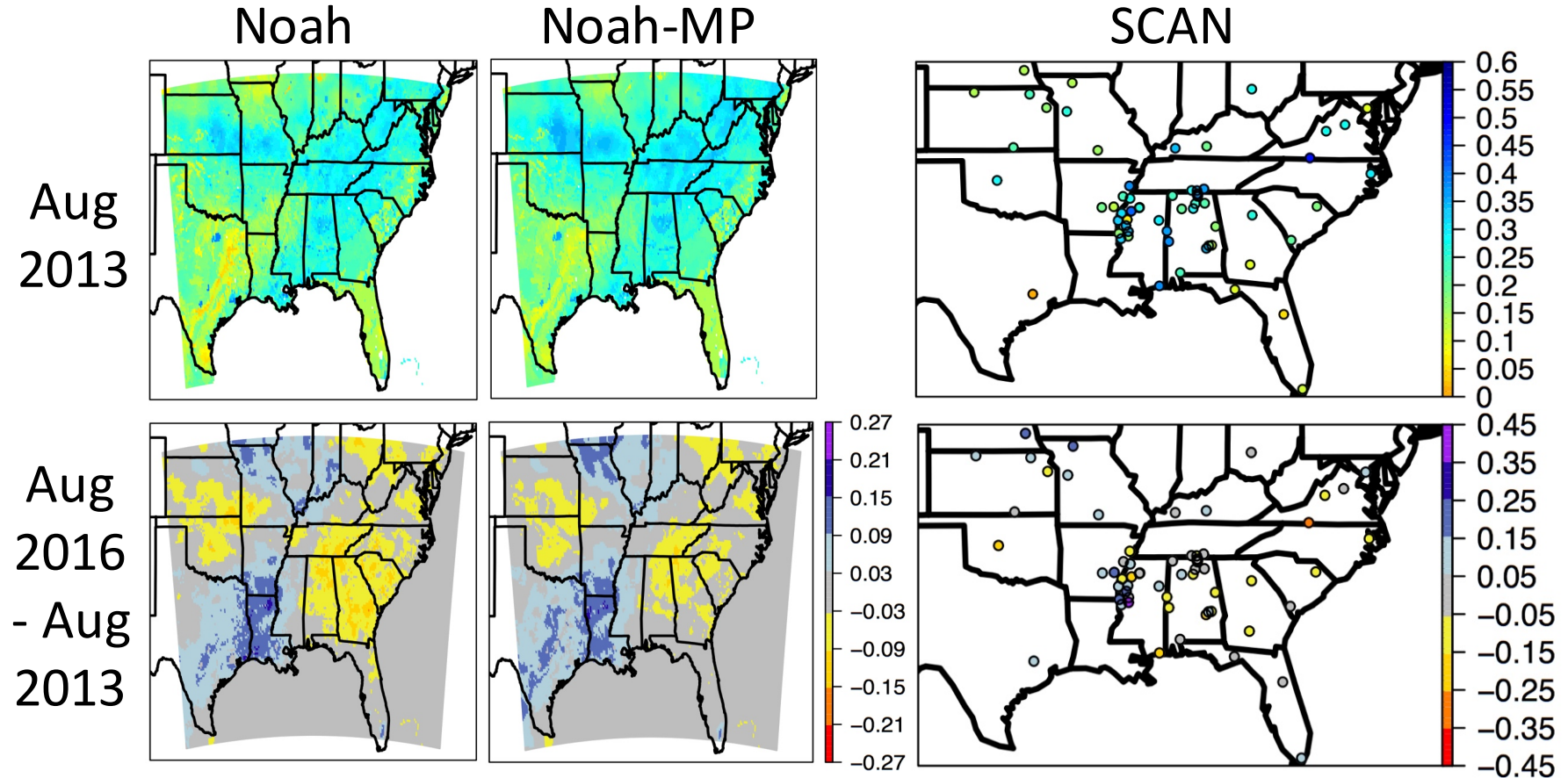
Emission-induced aerosol changes interact with radiation/temperature, affecting GPP & ET. GPP/ET (water use efficiency) indicates plants' resilience to environmental changes.

Ongoing: multi-LSM land DA, for SE US in 2013 & 2016

Palmer Drought Severity Index



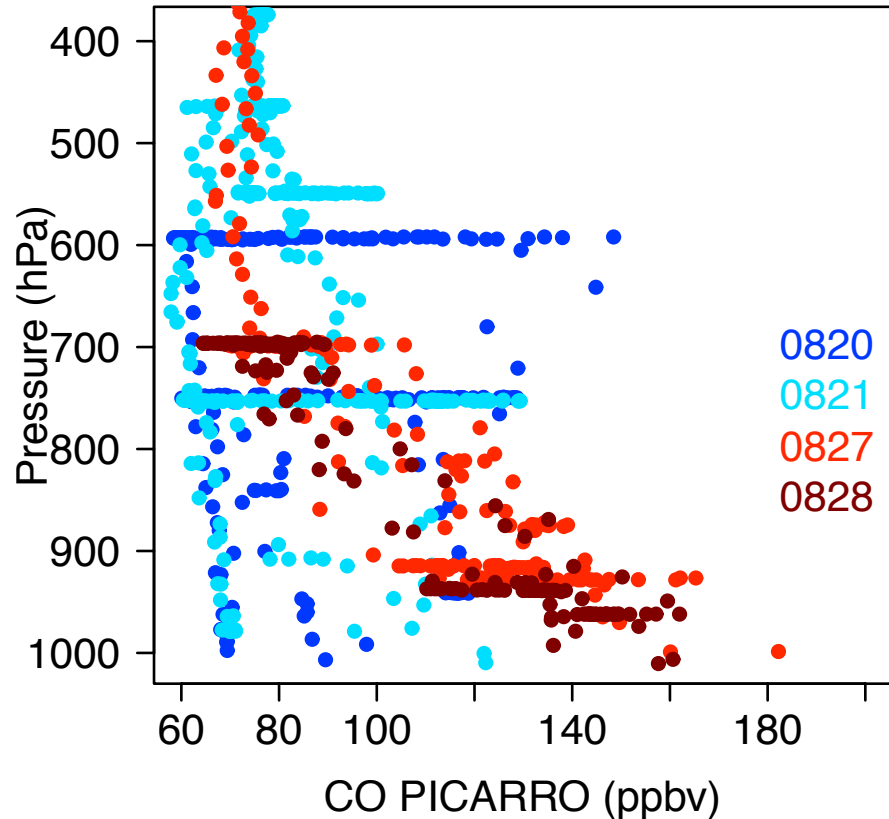
“Surface” soil moisture (SM, m^3/m^3)



- Drought conditions indicated by modeled & SCAN “surface” SM consistent with PDSI
- Inter-LSM differences in SM shown. Now assimilating satellite land products (SM, etc.) into both LSMs within LIS, coupled with NUWRF

Comparing events in regions with strong L-A interactions

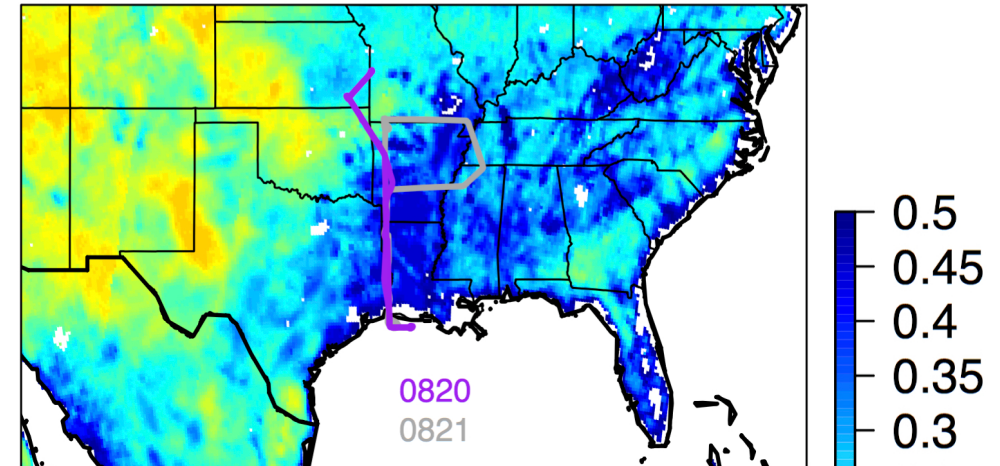
Aircraft CO during ACT-America



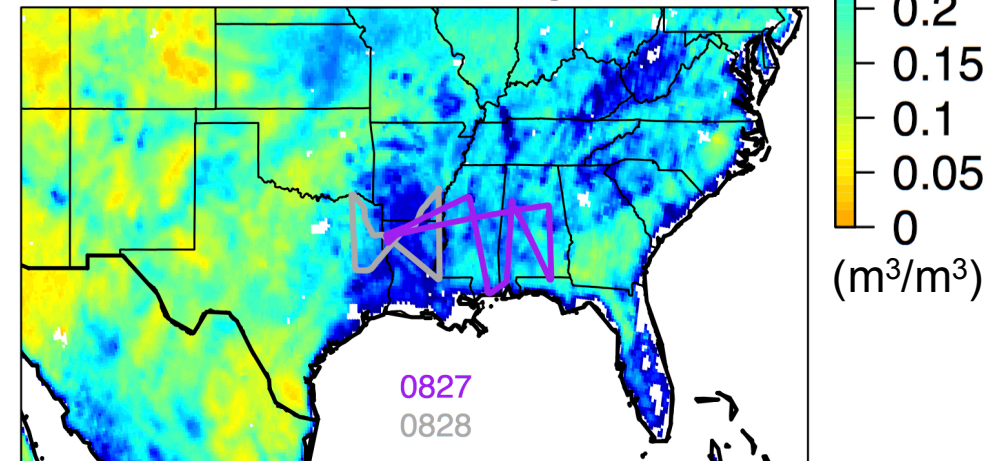
19-21 Aug 2016: convective weather

27-29 Aug 2016: fair weather

SMAP 19-21 Aug 2016



SMAP 27-29 Aug 2016

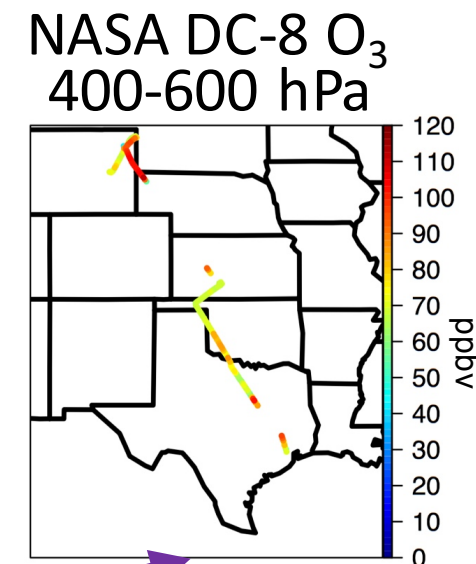
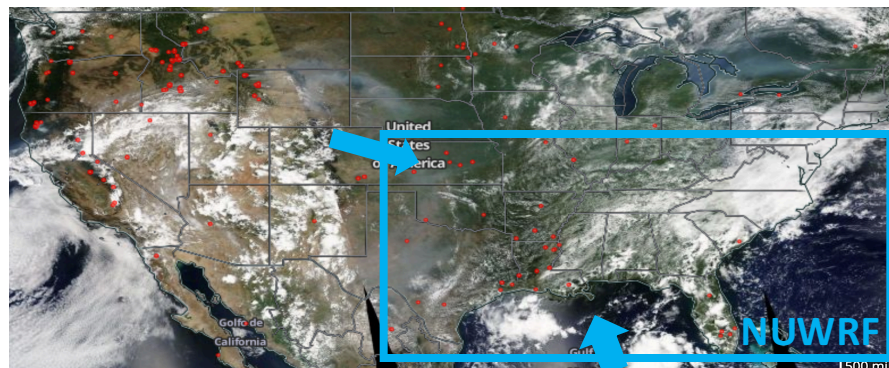


NUWRF atmospheric fields respond to land initialization differently during these events (more details at AGU)

Examining several BC/IC models w/ chemical DA

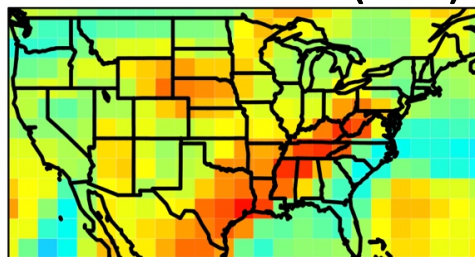
MODIS surface & active fire conditions

19 Aug 2013:
strong fire activities
captured by satellites
and a SEAC⁴RS flight

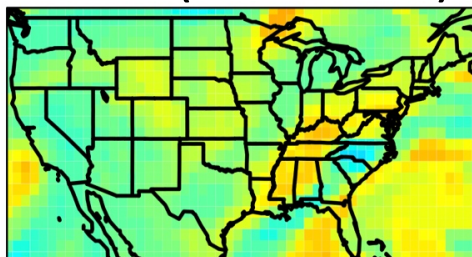


O₃ @18z
~500 hPa

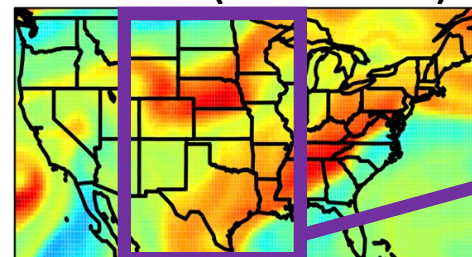
GEOS-Chem (JPL)



TCR2 (JAMSTEC)



CAMS (ECMWF)



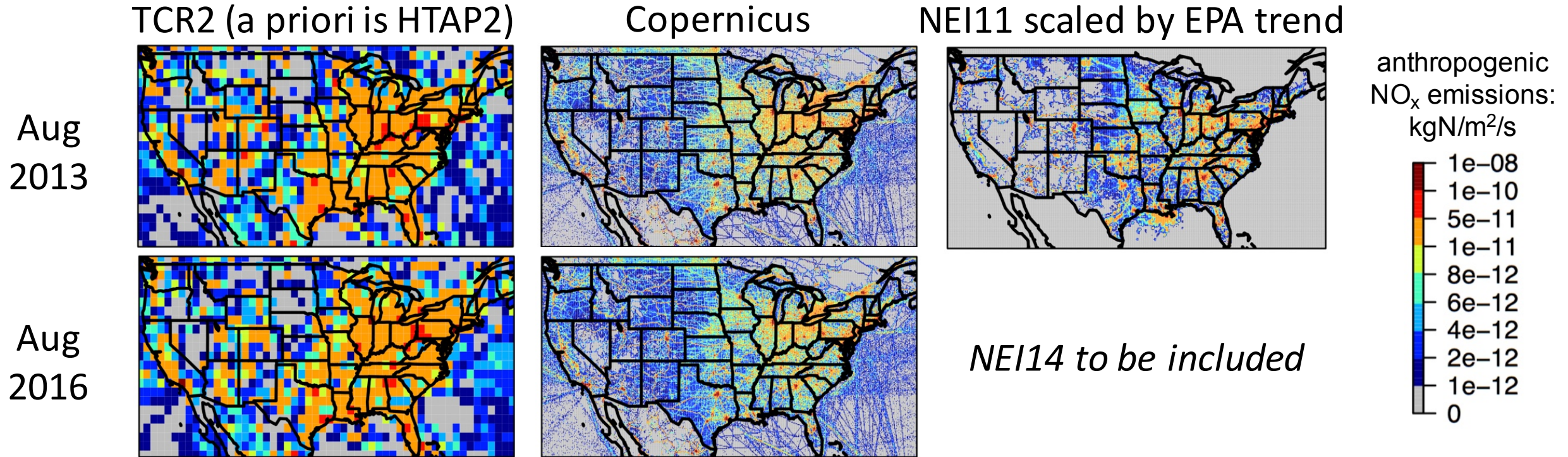
BC in current work on SE US

- WUS, central America influences of concern
- 3 global systems w/ multispecies chemical DA
- More chemical species analyzed & more attention to species mapping

BC in previous works on WUS (poster)

- Influenced by stratosphere, Asia ...
- 1 global chemical DA system vs. the free-running system(s)

Emissions: toward reconciling projected inventories & observation-constrained estimates



- Substantial differences in spatial variability and temporal changes of emissions. These differences and their impacts on NUWRF results are being studied.
- Also looking into other emissions; anthropogenic emissions of some species are being co-adjusted referring to aircraft observations from SE US field campaigns

Other current efforts and next steps

- Extended interannual and inter-event comparisons: 2019 to be covered
- Intensively addressing connections between land surface and fire situations
- Utilizing data from newer missions: e.g., TROPOMI, OCO3, ECOSTRESS (ISS orbit, diurnal variability), FIREX-AQ, GEDI ...
- Taking advantage of the very recent (summer 2019) updates in CAMS: higher vertical resolution (60 L \rightarrow 137 L), improved aerosols

More information in poster

**Thanks to Aura & other science teams
& your attention**

